

## Original Article

# Incidences of C5 nerve palsy after multi-segmental cervical decompression through different approaches

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**Abstract: Objective** To investigate the incidence of C5 nerve root palsy after multi-segmental cervical decompression through different approaches. **Methods** This study was conducted among 375 patients undergoing multi-segmental cervical decompression in anterior corpectomy and fusion fixation, anterior cervical corpectomy and fusion fixation + posterior decompression and fusion fixation, posterior cervical laminectomy decompression, fusion and internal fixation, and posterior laminoplasty and fusion groups. The exclusion criteria included lack of follow-up data, spinal cord injury preventing preoperative or postoperative motor testing, or surgery not involving the C5 level. The incidence of C5 palsy was determined and the potential risk factors C5 palsy were analyzed including age, sex, revision surgery, preoperative weakness, diabetes, smoking, number of levels decompressed, and a history of previous upper extremity surgery. **Results** Of the 375 patients, 60 patients were excluded and the data of 315 patients were analyzed, including 146 women and 169 men with a mean age of 57.7 years (range 39-72 years). The overall incidence of C5 nerve palsy was 6.03% (19/315) in these patients; in the subgroups receiving different surgeries, the incidence was 8.62% in the cervical road laminectomy and fusion fixation group, 7.79% in the anterior cervical corpectomy and fusion fixation + posterior decompression and fusion and internal fixation, 4.68% in the anterior corpectomy and fusion fixation group, and 3.85% in the posterior laminoplasty and fusion group. No significant difference was found in the incidences among the subgroups, but men were more likely than women to develop cervical nerve root palsy (8.28% vs 3.42%,  $P < 0.05$ ). **Conclusion** The overall incidence of C5 nerve palsy following postoperative cervical spinal decompression was 6.03% in our cohort. The incidence of C5 nerve palsy did not differ significantly following different cervical decompression surgeries, but the incidence was the highest in the posterior cervical laminectomy and fusion and internal fixation group.

**Key words:** cervical myelopathy; decompression; complications; C5 nerve palsy

## INTRODUCTION

C5 nerve palsy is a common complication after cervical decompression with an incidence of 0-30%<sup>[1]</sup>. The symptoms of C5 nerve palsy, including deltoid and biceps paralysis, sensory loss, and shoulder weak intractable pain, are usually unilateral, and bilateral symptoms are rare<sup>[2,3]</sup>.

The etiology of C5 nerve palsy remains unclear, but iatrogenic injuries of the spinal cord during cervical surgery (such as spinal cord displacement and ischemia-reperfusion injury) are often thought to contribute to its occurrence. C5 nerve palsy can occur in different manners during decompression surgeries<sup>[4-6]</sup>, but so far no studies have been reported to compare its incidence after multi-segmental cervical decompression through the anterior, posterior, and combined approaches<sup>[7]</sup>.

The purpose of this study was to elucidate whether the incidence of postoperative cervical nerve root palsy differed after 4 different surgical approaches for multi-segmental cervical decompression, namely (1) anterior corpectomy and fusion fixation, (2) anterior corpectomy and fusion fixation + posterior laminectomy, fusion and internal fixation, (3) posterior laminectomy, fusion and internal fixation, and (4) posterior

laminoplasty fusion and internal fixation.

## PATIENTS AND METHODS

### Patients

We retrospectively analyzed the clinical data of 375 patients who underwent cervical decompression spine surgery between January, 2006 and December, 2012. These patients received multilevel anterior cervical corpectomy and autograft fibular strut fusion, anterior corpectomy and fusion followed by posterior fusion, posterior laminectomy and fusion, or posterior laminoplasty procedures for treatment of cervical spinal stenosis. All the patients had at least two cervical segments decompressed. The patients were excluded from the study who had no adequate follow-up data, received a previous spinal cord injury, were unable to exercise preoperative or postoperative motor function testing, or received a decompression not involving the C5 level.

### Surgical approaches and data collection

The surgical approaches for decompression (anterior, posterior, or combined) were determined by experienced spinal surgeons. Four approaches for multi-segmental cervical decompression were used for

Received: 2014-02-09

Accepted: 2014-09-22

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treatment of cervical stenosis, including (1) anterior corpectomy and fusion fixation, (2) anterior corpectomy and fusion fixation + posterior laminectomy, fusion, and internal fixation, and (3) posterior laminectomy, fusion, and internal fixation, and (4) posterior laminoplasty fusion fixation. In this study, C5 nerve palsy is defined as deltoid and/or biceps muscle weakness, C5 dermatome area hypoesthesia, or increased pain in the C5 distribution as compared with the preoperative status. The residual symptoms are defined as persistent symptoms (failure of full motor strength recovery in either the deltoid or biceps brachii, sensory deficits in the C5-innervated area, or increased pain in the C5-innervated area as compared with the preoperative pain intensity) after the end of the follow-up period. The patients' data including age, gender, preoperative physical condition, diabetes, smoking, and number of decompressed levels were collected and statistically analyzed to identify the risk factors contributing to C5 nerve palsy following the decompression surgeries.

Statistical analysis

The data are presented as *Mean±SD* and analyzed using Pearson  $\chi^2$  test, Fisher's exact test, and two-sample *t* test as appropriate. A *P* value less than

0.05 were considered to denote a statistically significant difference. All the statistical analyses were performed using SPSS 13.0 statistical software.

RESULTS

Of the 375 patients, 60 patients were excluded due to failure of regular follow-up (34 cases), a reduced scope of the C5 level (15 cases), or injury prior to the surgery or carotid C5 nerve palsy associated with spinal cord injury or shoulder discomfort (11 cases). In the remaining 315 patients, 128 patients were treated with anterior corpectomy, 77 had combined anterior treatment, 58 underwent posterior laminectomy decompression, and 52 received posterior lamina-forming treatment.

These 315 patients, including 146 women and 169 men with a mean age of  $57.65\pm15.74$  years (range 39-72 years), were followed up for a mean of 10 months. The detailed data of each group are shown in Tab.1.

Tab.1 shows no significant difference among the 4 groups in the incidence of C5 nerve root palsy ( $P=0.28$ ). To detect the difference in the incidences ranging from 3.85% to 8.62% with an 80% power Pearson  $\chi^2$  test, at least 256 patients shall be needed in each group, but the power of our test was 18%.

Tab.1 Summary of demographic data and surgical outcomes of the patients available for analysis

	Corpectomy	Corpectomy with posterior	Laminoplasty	Laminectomy and fusion	Overall
Procedure					
Patients	128	77	52	58	315
Male/Female	66/62	34/43	35/17	34/24	169/146
Age (year)	54.72±11.83	57.91±10.34	60.03±9.12	63.32±10.45	57.65±15.74
Incidence of C5 palsy	6 (4.69%)	6 (7.79%)	2 (3.85%)	5 (8.62%)	19 (6.03%)
Symptom onset time (week)	2.51±0.49	4.23±1.77	3.54±2.33	2.12±0.33	2.59±2.74
Residual deficit	1(16.67%)	1(16.67%)	0(0%)	1(20%)	3(15.79%)
Time to maximal improvement (week)	18.11±2.13	28.51±3.12	21.82±1.23	18.31±2.31	20.86±2.52

Five (3.42%) of the 146 women and 14 (8.28%) of the 169 men developed C5 nerve palsy ( $P<0.05$ ). Two of these 19 patients (10.52%) had bilateral symptoms, while 1 (5.26%) had paralysis involving more than one segment. The time of initial onset of the C5 nerve root palsy symptoms ranged from immediately following the surgery to 8 weeks after the surgery, and the symptoms completely resolved in the majority of patients within 24 weeks. But 15.79% of the patients still had residual pain after the follow-up period ended. The laminoplasty group had the lowest rate (0) of residual symptoms, while the posterior laminectomy and fusion fixation group had a rate up to 20%, but no significant difference was found in the rates between the latter two groups. Cervical nerve root palsy symptoms disappeared as soon as 1 week postoperatively or until as long as 2 years after the onset, with a mean of 21 weeks; the symptoms disappeared within 6 months in 71.4% of the patients. The mean age of the patients with postoperative cervical nerve root palsy was 57.6 years, similar to that of patients without C5 nerve palsy (58.6 years,  $P=0.558$ ).

Tab.2 shows the possible risk factors of C5 nerve

palsy associated with the 4 surgical procedures. In the anterior and posterior fusion group and the laminectomy and fusion group, none of the factors tested appeared to contribute to C5 nerve palsy. In the anterior corpectomy group, the number of levels decompressed was significantly greater in the 6 patients with C5 nerve palsy ( $P=0.002$ ), among whom 5 received 3-level cervical corpectomy. Age was also a risk factor in this subgroup, and the symptomatic patients had a significantly greater age than those without symptoms ( $62.43\pm10.31$  vs  $54.32\pm13.38$  years,  $P=0.01$ ). The other variables listed were not statistically significant in the corpectomy group. In the posterior laminoplasty group, age was also a significant factor related to the development of C5 nerve palsy, and the mean age of patients developing C5 nerve palsy was 47 years compared to 60 years in the asymptomatic patients ( $P=0.04$ ).

DISCUSSION

In this study, we found that the overall incidence of C5 nerve palsy following cervical decompression of

chinaXiv:201712.01144v1

Tab.2 Summary of subgroup statistical analysis by potential risk factor based on surgery type (*Mean±SD* or number of cases)

Risk Factor	Palsy	Corpectomy	Anterior/Posterior Fusion	Laminoplasty	Laminectomy and fusion
Age (year)	Yes	62.43±10.31	58.47±10.13	47.13±8.21	55.56±14.75
	No	54.32±13.38	55.42±11.34	60.34±10.33	56.75±15.47
	<i>P</i>	0.01*	0.44	0.04*	0.14
Gender ratio (M/F)	Yes	3/3	3/4	1/1	3/2
	No	63/59	31/39	34/16	31/22
	<i>P</i>	0.37	0.26	0.15	0.19
Smoking	Yes	3	4	1	4
	No	61	46	25	42
	<i>P</i>	0.32	0.24	0.35	0.57
Previous cervical surgery	Yes	0	1	0	0
	No	2	3	1	1
	<i>P</i>	0.40	0.31	1.00	0.26
Previous upper extremity surgery	Yes	1	1	0	1
	No	7	5	3	2
	<i>P</i>	0.50	0.11	0.38	1.00
Diabetes	Yes	3	2	1	2
	No	22	10	15	13
	<i>P</i>	0.35	0.39	0.57	0.49
Preoperative weakness	Yes	1	0	0	1
	No	6	2	2	4
	<i>P</i>	1.00	0.50	0.35	0.40
Number of levels decompressed	Yes	3.01±1.11	1.52±0.51	2.13±1.04	2.52±1.49
	No	1.23±0.49	1.49±0.62	2.21±1.13	2.63±1.43
	<i>P</i>	0.002**	0.27	0.41	0.22

The data were compared using Pearson  $\chi^2$  test or two-sample t test in each group.

multiple adjacent segments was 6.03% , close to previously reported results<sup>[8]</sup>. No significant difference was found in the incidences of C5 nerve palsy among patients receiving different surgical procedures. According to our data, there was no significant difference in the risk of developing postoperative C5 nerve palsy based on the type of surgery.

C5 nerve palsy occurs commonly within the first 2 weeks after the surgery, and the symptoms disappear mostly within 24 weeks. This study revealed that this complication could occur up to 2 months postoperatively; 15.79% (3/19) of the patients with C5 nerve palsy still had residual symptoms at the end of the follow-up period and were considered to have residual deficits. These symptoms improved within 21 weeks in most of the patients (84.21%).

The risk factors for postoperative C5 nerve palsy included the male gender and the number of corpectomy levels. Men were more likely to develop C5 nerve palsy than women (8.28% *vs* 3.42% ), and an increasing number of corpectomy levels was associated with a significant increase in C5 nerve palsy rates (*P*<0.05). In the subgroup analysis, age was identified as a significant risk factor in the corpectomy and laminoplasty groups. In the corpectomy group, an older age was associated with a higher incidence of C5 nerve palsy, but in the laminoplasty group, the patients with C5 nerve palsy had a younger age than those free of symptoms. This discrepancy was most probably incidental due to the relatively small number of patients in each subgroup. In the overall patients, no association was found between

the patients' age and the development of C5 nerve palsy.

Researchers previously thought that intraoperative electromyographic (EMG) monitoring was useful for detecting C5 nerve paralysis during surgery<sup>[9,10]</sup>. Intraoperative EMG is sensitive in detecting motor-evoked potentials (MEP), but not all C5 nerve palsy can be found by intraoperative EMG monitoring<sup>[11-13]</sup>, although it does help to understand why some of the patients' symptoms disappear soon after surgery<sup>[14]</sup>. A recent study found that somatosensory-evoked potentials (SSEP) monitoring did not alert the surgeon of any impending C5 nerve palsy during the surgical procedures. MEP or EMG monitoring was thus not routinely used in our patients<sup>[15-17]</sup>.

Another method of avoiding C5 nerve palsy is to perform prophylactic foraminotomies during either laminoplasty or laminectomy, but this remains controversial since its effect has not yet been confirmed<sup>[18-21]</sup>. The principle is that posterior cervical spinal decompression can cause posterior shifting of the spinal cord due to C5 nerve stretching<sup>[22, 23]</sup>. In this study, posterior decompression did not include preventive foramen decompression.

In preoperative imaging studies, the presence of carotid stenosis of the C3-4 level and C5 neural foramen stenosis increased the risk of C5 nerve palsy in posterior cervical spinal surgery; if C5 nerve stretch was accompanied by C5 neural foramen stenosis, the symptoms could be worse<sup>[24]</sup>. Imagama et al reported that a narrow C5 nerve hole formation significantly increased the incidence of postoperative C5 nerve palsy<sup>[25]</sup>.

The limitations of this study include its retrospective design and its lack of detailed imaging data and documentation of clinical signs. Future studies are warranted to determine the association of the severity of preoperative stenosis with imaging findings and preoperative clinical findings. In addition, the lack of preoperative and postoperative radiographic contrast prevents imaging-based prediction of the occurrence of C5 nerve palsy<sup>[26]</sup>.

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## 各种多节段颈椎减压术后颈5神经根麻痹发生率的比较

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**摘要:**目的 研究采用不同的颈椎手术方式进行颈椎减压术后颈5神经根麻痹的发生率。方法 回顾分析375名仅进行相连多节段颈椎减压手术的患者。研究对象为进行颈椎多节段减压的患者。手术方式包括前路椎体次全切除植骨融合内固定术、颈椎前路椎体次全切除植骨融合内固定术+后路减压植骨融合内固定术、颈椎后路椎板切除减压、植骨融合内固定术及后路椎板成形植骨融合术。对于没有定期随访、由于脊髓损伤造成术前及术后无法查体对比、手术范围不包括颈5椎体的患者均被剔除研究组。观察颈5神经根麻痹是否与患者的年龄、性别、术前是否接受过颈椎手术、术前身体状况、糖尿病、吸烟、减压范围及术前是否有上肢疾病等多因素比较是否具有统计学差异。结果 在375名患者中, 60名患者被剔除, 315名患者纳入研究, 包括146名女性患者和169名男性患者, 平均年龄57.7岁(39~72岁)。本研究中颈5神经根麻痹的总发生率为6.03%(19/315), 在各手术组别中, 颈椎后路椎板切除减压、植骨融合内固定组发生率最高, 为8.62%; 其次为颈椎前路椎体次全切除植骨融合内固定术+后路减压植骨融合内固定组, 为7.79%; 前路椎体次全切除植骨融合内固定组为4.68%; 后路椎板成形植骨融合组为3.85%, 各组别之间无统计学差异。男性患者较女性更易出现颈5神经根麻痹(8.28% vs 3.42%,  $P<0.05$ )。结论 颈椎减压术后颈5神经根麻痹的总发生率为6.03%, 与之前报道结果接近。在各种颈椎减压手术方式之间颈5神经根麻痹的发生率无统计学差异, 但颈椎后路椎板切除减压、植骨融合内固定组中颈5神经根麻痹的发生率最高。

**关键词:**颈椎; 脊髓型颈椎病; 减压; 并发症; 颈5神经根麻痹

收稿日期: 2014-02-09

基金项目: 西安市卫生局基金(2012017)

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